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BULLETIN

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Notes on Maize.

By E. Lewis Sturtevant.

XI.

My own experiments on the pollination of corn have been from the planting of many varieties and seed-selections in juxtaposition, and then studying the crop produced. Where commercial seed or named samples were used, and the crop critically examined for off kernels, the result was:

Zea everta. 1883, one variety, all pop kernels; 1884, five varieties, all pop kernels; 1885, three varieties, all pop kernels.

Zea indurata. 1883, ten varieties, all flint kernels; 1884, nineteen varieties, all flint kernels; 1885, three varieties, all flint kernels.

Zea indentata. 1883, twelve varieties, all dent kernels; 1884, eleven varieties, all dent kernels; 1885, two varieties, and one had some flint kernels.

Zea amylacea. 1883, one variety, and some flint kernels; 1884, nine varieties, and all soft kernels; 1885, four varieties, and one had some flint kernels.

Zea saccharata. 1883, twenty-seven varieties, and of these twenty-four had some flint kernels; 1884, thirty-five varieties, and of these five had some dent kernels, and twenty-nine had some flint kernels; 1885, ten varieties, and of these two had some dent kernels, five had some flint, one had some flint and soft, and one had some flint, dent and soft kernels.

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* Continued from Bulletin, Aug. 1894, p. 343.

We hence would conclude that current fertilization, or the effect of the pollen of the same year, is not facile between the species except in the case of the sweets. Professor Kellerman, of the Kansas Experiment Station, in the Report for 1888, p. 331, gives the result of artificial crossings, as below:

Pop × dent. 1 trial. No evidence of a cross.
Flint × pop. 1 trial. " "
Flint × flint. 3 trials. " "
Flint × dent. 7 trials. " "
Flint × sweet. 1 trial. " "
Dent × pop. 2 trials. No certain evidence of a cross.
Dent × flint. 4 trials. No evidence of a cross; 1 trial, slight evidence of a cross.
Dent × dent. 6 trials. No clear evidence of a cross.
Dent × sweet. 2 trials. No evidence of a cross.
Sweet × pop. 3 trials. Clear evidence of a cross.
Sweet × flint. 1 trial. Doubtful evidence of a cross; 2 trials, clear evidence of a cross.
Sweet × dent. 1 trial. No evidence of a cross; 2 trials, apparent evidence of a cross.
Sweet × sweet. 3 trials. No evidence of a cross.

Thus the evidence collected by two different methods give results in unison; as shown more clearly below:

Female parent.	Sturtevant.	Kellerman.
Zea everta.	No evidence in favor.	No evidence in favor.
indurata.	do	do
indentata.	Slight evidence in favor.	Slight evidence in favor.
amylacea.	do	—
saccharata.	Much evidence in favor.	Much evidence in favor.

That corn will self-fertilize seems evident from the always finding of kernels, and occasionally well-filled ears, on plants from single kernels that either accidentally or purposely have grown remote from other plantings of their kind. This positive evidence, perhaps not conclusive on account of the facility by which pollen is moved by the wind, seems to me to outweigh the negative results reported by observers for definite trials.

That corn cross-fertilizes readily is evident to the most careless observer. Even the Indians of New England had noticed the fact, but had attributed the cause to the roots reaching to and communicating with each other. The result of inter-crossings, as expressed in the ears, and given below from the data obtained from the use of seed grown under conditions that almost compelled interchange of pollen, and some of the seed taken from ears of other varieties or species than their own.

Zea everta. 1883, nineteen plantings, of these seven produced pop and flint ears, twelve produced all pop ears; 1884, eight plantings, of these one produced pop and flint ears, and seven all pop ears; 1885, fourteen plantings, all produced pop ears.

Zea indurata. 1883, nine plantings, of these three produced flint and dent ears, one produced flint, dent and soft ears, and five produced all flint ears; 1884, seventeen plantings, of these three produced flint and dent ears, one produced flint and pop ears, one produced flint, dent and pop ears, one produced flint and soft ears, and eleven produced all flint ears; 1885, twenty-eight plantings, of these three produced flint and pop ears, three produced flint and dent ears, one produced flint and sweet ears, one produced sweet and pop ears, and twenty produced all flint ears.

Zea indentata. 1883, thirteen plantings, of these four produced dent and flint ears, one produced sweet and flint ears, and six produced all dent ears; 1884, ten plantings, of these three produced dent and flint ears, one produced dent, flint, soft and pop ears, and six produced dent ears alone; 1885, thirteen plantings, of these five produced dent and flint ears, one produced dent, flint and pop ears, and seven produced all dent ears.

Zea amylacea. 1883, six plantings, all producing soft ears; 1884, two plantings, both producing soft and flint ears; 1885, thirteen plantings, of these one produced soft and flint ears, and twelve produced all soft ears.

Zea saccharata. 1883, five plantings, of these two produced sweet, pop and flint ears, one produced sweet and pop ears, and two produced all sweet ears; 1884, ten plantings, all producing sweet ears; 1885, forty-one plantings, of these one produced sweet and dent ears, one produced sweet and flint ears, one produced all flint ears, and thirty-eight produced all sweet ears.

This presentation is an interesting one, but it does not show the full significance, nor the part that atavism has furnished. It will be noticed that the ears noted are all of the species named, and that there are no intermediates. I propose hence to examine the crop of 1885, the seed used having been all exposed to cross-fertilization in 1884, and much of it in 1883 and 1884. The varieties as named were all compared with authentic specimens or with careful drawings. Variables which could not be named were passed by, as are also those plantings whose crop was all true to type. I have added to each name the letters A, B or C, indicating the sub-species.

Zea everta seed.

Quarantino (C). Yielded some ears of New England Twelve-rowed pop (B). A few flint kernels in crop.

White Pearl (C). Yielded some ears of Red Pearl pop (C).

Small White Pearl (C). Yielded some ears of Common Twelve-rowed pop (C).

New England Yellow (A). Yielded some ears of New England pop (A), and some of Egyptian pop (C).

Purple Rice (C). Yielded some ears of Yellow Egyptian pop (C), and some of Red Pearl pop (C).

Pearl (C). Yielded some ears of Small Pearl pop (C). A few sweet kernels in the crop.

Red Pearl (C). Yielded some ears of White Pearl pop (C).

Twelve-rowed from Amber Rice seed (C). Yielded some ears of Yellow New England pop (A), and some ears of Red New England pop (A).

Amber Rice (C). Yielded some ears of Twelve-rowed pop (B), and some ears of Egyptian pop (C).

Amber Rice (C). Yielded some ears of Red Rice pop (C), and some ears of New England pop (A).

Zea indurata seed.

French Yellow Six Weeks (C). Produced some ears of Quarantino pop (C).

Compton's Early (B). Produced some ears of Canada Twelve-rowed flint (B). Some sweet kernels in crop.

New England Eight-rowed (A). Produced some ears of Long Yellow flint (A), some ears of Canada Twelve-rowed flint (B). Some sweet kernels in crop.

Maize from Africa A (C). Produced some ears of African E. 3 dent, but yellow kernelled (C).

White flint kernels from Egyptian sweet (C). Produced some ears of Egyptian pop, some ears of Canada flint (A), and some ears of Chinese Golden flint (C). Some sweet kernels in crop.

Rural Thoroughbred (A). Produced some ears of Rhode Island White Cap flint (A), and some ears of Benton dent (A).

Flint kernels from Benton dent (A). Produced some ears of Benton dent (A), some ears of Eight-rowed Brown flint (A), and some ears of Orange flint (A).

Black flint kernels from Black Mexican sweet (A). Produced some ears of Black Mexican sweet (A), and some ears of Black Sugar sweet (B). Some flint kernels in the crop.

Flint kernels from Early Minnesota sweet (A). Produced some ears of Genesee sweet (B), and some ears of New England pop (A). Some flint kernels in the crop.

Canada Twelve-rowed (B). Produced some ears of Canada flint (A), and some ears of Early Fulton flint (B). Some sweet kernels in the crop.

Golden Dew Drop (A). All the ears Canada flint (A), and Canada Twelve-rowed flint (B).

Purple New England Eight-rowed (A). Produced some ears of Canada flint (A), and some ears of Waushakum flint (A). Some sweet kernels in the crop.

Flint kernels from Moore's Early Concord sweet (B). Produced some ears of New England pop (A), some ears of Canada flint (A), some ears of New England Eight-rowed flint (A), some ears of Chinese Golden flint (C), and some ears of African E. 2 flint (C). Some sweet kernels in the crop.

Sanford (A). Produced some ears of Silver White flint (A).

Flint kernels from Golden sweet (B). Produced some ears of Chinese Golden flint (C), some ears of Canada flint (A), and some ears of Canada Twelve-rowed flint (B). Some sweet kernels in the crop.

Flint kernels from flint kernels in Sibley's Pride of the North dent (C). Produced mostly ears of Waushakum flint (A), and some ears of Mandan flint (A).

Flint kernels from Marblehead Mammoth sweet (B). Produced some ears of Canada flint (A), and some ears of White Pearl pop (C). Some sweet kernels in the crop.

Blue flint kernels from flint kernels on Golden sweet (B). Produced some ears of Canada flint (A), and some ears of New England Eight-rowed flint (A). Some sweet kernels in the crop.

Flint kernels from Mandan soft (A). Produced all Connecticut White flint (A) ears.

Improved Early Canada (A). Produced some ears of Smedley dent (C), some ears of Canada flint (A), and some ears of New England Eight-rowed flint (A).

Zea indentata seed.

Dent kernels from Landreth's Sugar sweet (C). Produced some ears of Forty Days flint (A), some ears of African E. 1 flint (C), and some ears of Chinese Golden flint (C) in white kernels.

Dent kernels from flint on Early Eight-rowed sweet (A). Produced some ears of Benton dent (A), some ears of Adams' Early dent (C), and some ears of Illinois Yellow dent (C). Some sweet kernels in the crop.

Chester County Mammoth (C). Produced some ears of Sanford flint (A).

Dent kernels from Ne Plus Ultra sweet (C). Produced some ears of Chinese Golden flint (C), but white kernelled, some ears of Egyptian pop (C), and some ears of Canada Twelve-rowed flint (B). Some sweet kernels in the crop.

Adams Early (C). Produced some ears of Benton dent (A), and some ears of Long Island dent (A).

Benton dent (A). Produced some ears of Waushakum flint (A).

Dent kernels from flint on Sibley's Pride of the North (C). Produced some ears of Smedley dent (C), some ears of Waushakum flint (A), and some ears of Eight-rowed Brown flint (A).

Adams Early (C). Produced some ears of Benton dent (A), and some ears of Long Island dent (A).

Champion White Pearl (C). Produced some ears of Adams Early dent (C).

African Maize E. 3 (C). Produced some ears of Chinese Golden flint (C), some ears of Waushakum flint (A), and some ears of Benton dent (A). Some sweet kernels in the crop.

Sibley's Pride of the North (C). Produced some ears of Smedley's dent (C).

Zea amylacea seed.

Red River (A). Produced some ears of Mandon soft (A).

Zuni Yellow (B). Produced some ears of Zuni Purple soft (B), and some ears of Canada flint (A).

Omaha (A). Produced some ears of Canada flint (A) in red color.

Zea saccharata seed.

Amber sweet kernels from Brighton Orange sweet (B). Produced some ears of Tom Thumb sweet (A), and some ears of Orange sweet (B). Some flint kernels in the crop.

Early Marblehead (A). Produced some ears of Amber Queen sweet (B). Some flint kernels in the crop.

Golden sweet kernels from flint on Golden sweet (B). Produced some ears of Golden Eight-rowed sweet (A), and some ears of Black Mexican sweet (A). Some flint kernels in the crop.

White sweet kernels from New England pop (A). Produced some ears of Darling's Early sweet (A), and some ears of Marblehead sweet (A). Some flint kernels in the crop.

White sweet kernels from New England pop (A). Produced some ears of Minnesota sweet (A), and some ears of Amber Cream sweet (B). Some flint kernels in the crop.

Minnesota (A). Produced some ears of Eight-rowed Early sweet (A), and some ears of Amber Cream sweet (B). Some flint kernels in the crop.

Moore's Early (B). Produced some ears of Golden Eight-rowed sweet (A). Some flint kernels, and some dent kernels in the crop.

Black sweet kernels from flint on Golden sweet (B). Produced all Black Mexican sweet (A) ears. Some flint and some soft kernels in the crop.

Asylum (B). Produced some ears of Amber Cream sweet (B), and some ears of Crosby's Early sweet (B). Some flint kernels in the crop.

Alexander's sweet (A). Produced some ears of Amber Cream sweet (B), and some ears of Eight-rowed Early sweet (A). Some flint kernels in the crop.

Black sweet kernels from Brighton Orange sweet (B). Produced all Black Mexican sweet (A) ears. Some flint kernels in the crop.

Dolly Dutton (A). Produced some ears of Narragansett sweet (A). Some flint kernels in the crop.

Black sweet kernels from Crosby's Early sweet (B). Produced some ears of Black Sugar sweet (B), some ears of Crosby's Early sweet (B), and some ears of Dwarf Early sweet (A). Some flint kernels in the crop.

Half sweet and flint on same kernels from Crosby's Early sweet (B). Produced some ears of Eight-rowed Early sweet (A), but kernels all black, and some ears of Crosby's Early sweet (B). Some flints kernels in the crop.

Black Mexican (A). Produced some ears of Amber Cream sweet (B), but black kernelled. Some flint kernels in the crop.

Ne Plus Ultra (C). Produced some ears of Eight-rowed Early sweet (A), and some ears of Hickox sweet (B). Some flint, some soft and some dent kernels in the crop.

Yellow sweet kernels from flint on Early Eight-rowed sweet (A). Produced some ears of Golden Eight-rowed sweet (A), some ears of Golden sweet (B), and some ears of Benton dent (A). Some flint kernels also in the crop.

Half sweet and flint in same kernel from Early Minnesota sweet (A). Produced some ears of Minnesota sweet (A), some ears of Narragansett sweet (A), and some ears of Eight-rowed Early sweet (A). Some flint kernels in the crop.

Black sweet kernels from Brighton Orange sweet (B). Produced some ears of Orange sweet (B), and some ears of Black Mexican sweet (A). Some flint kernels in the crop.

White sweet kernels from Brighton Orange sweet (B). Produced some ears of Tom Thumb sweet (A), and some ears of Crosby's Early sweet (B). Some flint kernels in the crop.

Tom Thumb (A). Produced some ears of Minnesota sweet (A). Some flints and some some soft kernels in the crop.

Dwarf Early (A). Produced some ears of Eight-rowed Early sweet (A), and some ears of Crosby's Early sweet (B). Some flint kernels in the crop.

Landreth's Sugar (C). Produced some ears of Long Yellow flint (A). Sweet kernels and dent kernels in the crop.

Marblehead Mammoth (B). Produced some ears of Genesee sweet (B). Some flint and many dent kernels in the crop.

Amber Cream (B). Produced some ears of Crosby's Early sweet (B). Some flint kernels in the crop.

Black Mexican (A). Produced some ears of Black Sugar sweet (B). Some flint, some soft and some dent kernels in the crop.

Squantum (C). Produced some ears of Genesee sweet (B). Some flint, some dent and some soft kernels in the crop.

Egyptian sweet (C). Produced some ears of Crosby's Early sweet (B). Some flint and some dent kernels in the crop.

The number of plantings that produced off and named ears and off kernels in their crop, according to their species, are summarized in the following table:

	No. of plantings.	Pop.		Flint.		Dent.		Soft.		Sweet.	
		Ears.	Kernels.	Ears.	Kernels.	Ears.	Kernels.	Ears.	Kernels.	Ears.	Kernels.
Zea everta, ...	10	—	—	0	1	0	0	0	0	0	1
Zea indurata, ...	20	5	5	—	—	4	4	0	0	2	11
Zea indentata, ...	11	1	1	6	6	—	—	0	0	0	3
Zea amylacea, ...	3	0	0	2	2	0	0	—	—	0	0
Zea saccharata, ...	28	0	0	1	28	1	8	0	5	—	—

This phenomena of atavism, as the outcome of the crossing of corn, has apparently escaped the notice of writers, and the testimony here furnished is in evidence of its frequent occurrence.

In 1882 seed of Waushakum flint was planted alongside many other varieties, and exposed to crossings of many sorts. No influence of other pollen was observed in the crop. In 1883 seed from the 1882 crop was again planted on a half-acre area greatly exposed to the pollen of over 100 kinds. In this crop no influence of other varieties was to be seen. In 1884 the same condition of things, and the resulting crop purely on type. So again in 1885. We have here a strong piece of evidence in favor of the resistance to crossing from plants from pure seed. Similar instances are afforded by the Silver White flint and the Minnesota dent. The former has been the only variety grown from time immemorial by the few farmers in a secluded valley in Orange county, N. Y., and the latter seems to be the only variety of dent grown near Ogdensburg, N. Y. *Per contra*, one plot of Waushakum flint was alongside a plot of Minnesota dent in 1882. In 1883 seeds from both plots yielded a crop of corn partly Minnesota dent and partly Waushakum flint, and no intermediates.

It is to the rarity of intermediates and the prevalence of atavism that we may look for the explanation of the frequent statements of flint changing to dent or dent to flint when seed has been obtained from distant localities; a result popularly ascribed to influence of climate. It is to be observed that the change is always towards the prevailing variety of the locality where the attempt is made. Let us offer a supposed instance for illustration. A farmer in Maine, where flint corn is exclusively grown, plants some dent corn on trial. The plants become hybridized from the neighboring plants. The next year's sowing yields flint and dent ears, the former ripe, the latter immature at the period of harvest. The ripened seed, that is, the flint, is saved for next year's use. The next year the crop is almost entire flint, and the farmer certifies at his next corn-talk that dent always changes to flint in his climate. The result here is influenced in great part by an unconscious selection. This illustration also seems to hold true in explaining the statements that Canada flint becomes larger when removed southward. This may be true, but I know of no good evidence in favor of such a change being produced by climatic conditions alone, although I admit its possibility. The Dwarf Golden pop, very small kernelled, retains its character for years, as grown by some farmers, not even changing to the very near but larger eared Golden pop of our seedsmen. One striking illustration may be offered. In 1883 I received some Minnesota dent corn from New York which had been grown near the Dutton flint. The ears and the kernels were apparently the true Minnesota dent. The crop was a flint corn, the dent character having largely disappeared. This change in variety receives again illustration in a planting of Dwarf Golden pop. The ears were from 1–2¼ in. long, with a bright yellow kernel. Thirty-six plants grew, of these thirty-two were two feet tall, the ears all like the seed except that one ear had a few sweet and flint kernels. The remaining four plants were four feet tall, and the kernels were all sweet, flint or Tuscarora soft, with not a pop among them.

From the data we have given it would seem that there is a ready cross-fertilization within each species, and a resistance, not very complete, to hybridization. But more work is yet required before accepting this conclusion.

In this "note" I have sought to indicate how nomenclature can be applied to simplify the study of such a confused mass of material as is furnished through the crossing of maize.

XII.

May 14, 1894, I received from Dr. Wm. Saunders, Director of the Canada Experimental Farms, a sample of the Squaw flint corn grown at Rat Portage, Lake of the Woods, lat. 50° N. The description of this variety, as made out from the cob and detached grains, is as below. Ear eight-rowed, six inches long; the ear stalk large. The taper quite pronounced from the slight dichotomous openings towards the butt, and the decreased breadth of the kernels towards the tip. Kernels broader than deep, very flinty, but the corneous matter rather thin; the larger ones $\frac{7}{16}$ inch broad. Colors mixed, some kernels dingy white, others of shades of yellow, light purple or blue. The cob, rather squarish in section, and white; the interior reddish, the pith soft and well defined. This variety seems to be the same with the Blue flint of Northern New England, but the ear tapering and more squarish, although not more so perhaps than in individual selections from a crop of the Blue corn. The dichotomous arrangement of the kernels and the openness between pairs can be understood by examining specimens of flint tassel corn. It will be noticed with this tassel corn that the tassel branch becomes changed on one side to a kind of triangular cob bearing two rows usually, when many kernels are found, although single kernels may occur in a scattered way. If four of these dichotomous kernelled branches be collected and tied together to form an ear we would have an eight-rowed ear with distinct openness between the pairs of rows. If search be made in a crop of flint corn we shall very likely find ears that are but partially kernelled, the kernels being scattered here and there only over the cob. These kernels are of the type of their species, but rounded through the removal of pressure against adjoining kernels, and often as thick as broad. The relations of these kernels to the cob are however of the greater interest. Where no kernels are found the cob is rather undeveloped; when the kernels are absent over a considerable space, even flimsy, but thickening again as the kernels appear. The cob hence varies in diameter according to the presence of kernels. If the observer is very fortunate he may find a cob with kernels in groups of different size. In this case he will observe that there is a tendency in the cob to develop according to the size of the kernels, as well as according to their number. We here have a plausible explanation for the taper in ears where the kernels diminish in size towards the tip; and this decrease in size of kernel, together with slight dichotomous openness in the upper portion, may give an ear of a most decided taper. I have frequently noticed in varieties of flint and sweet corn that the unripe ears always are tapering. This seems to be accounted for by the development of the kernel from the base upward; the butt kernels fertilizing first, the tip kernels last, and often quite an interval of time between. If these unripe ears be plucked at the period coincident with the commencement of the hardening process, or even in some cases slightly before, and allowed to continue the process of ripening from the stored material it will be noticed that the ear ripens but the taper remains, as the kernels do not increase equally in size. This explains, perhaps, the number of tapering ears in a belated crop of a variety whose normal ear would be described as cylindrical, but tapering towards the tip. This Squaw flint grown at a point somewhat near the extreme northern limit of the species, where the season is short, is, as we have seen, tapering, while the apparently same variety as grown in the Northeast is described as cylindrical or tapering very slightly at lower third. Since my description of Canada corn in 1884, as strictly of a cylindrical type, I have noted that I have observed among specimens of this type from northern localities some tapering ears. I have not sufficient data for generalization on this point, but it suggests itself that in any variety grown near its northern limit we should expect this variation to occur, a variation not incident to the variety, but to be ascribed to the accidental circumstance of harvest. Thus in the Black Mexican sweet, whose type of ears is cylindrical throughout, we often find belated ears which are distinctly tapering. This apparent change of type, as between normal and belated ears, is especially evident in the sweet corn, and has worked much confusion in the attempts at nomenclature.

We observe that our Squaw flint has various colored kernels on the cob. I readily pick out one dingy white, three shades of yellow, three shades of light purple, and two shades of blue. This mixture of colors is also to be noticed in the Mandan soft corns of Michigan and the Zuni soft corns of New Mexico, as also in others. Blue corn from Hanover, N. H., planted in 1884, yielded a crop described as copper-yellow, with some blue and slate-colored kernels, and many red-striped kernels. Whether these distinctly colored kernels arise through cross-fertilization or are a variety character can perhaps be determined by the planting of single kernels. It is possible that the colors from each seed come pure, and that the mixture is the result of current cross-fertilization between varieties. I have not the data for an answer. In my previous paper I have discussed current fertilization between species. Here I may be permitted to offer evidence of current fertilization between varieties as well. The experiment was with named varieties of flint corn, which, as experience has shown, would have yielded in all probability single colors had they been planted apart. As it was, these were planted subject to crossing from very numerous varieties of all the species. The colors grown together were white, yellow, red and purple pops; white, yellow, copper-red, purple and purple-brown flints; white, red and yellow dents; slate, pink, black, yellow and white softs; and white, amber and black sweets. The results noted for these flint corns were as below:

Forty Days' Early White. 34 ears, all flint. Yellow, white and pink striped kernels.

Eight-rowed Brown. 30 ears, all flint. Purple-brown, copper-red, yellow, red-splashed, slate and black kernels.

Eight-rowed red-glazed. 31 ears, all flint. Yellow, copper red, white, slate, red and splashed kernels.

Waushakum. Pure seed. 16 ears, all flint. Yellow kernels.

Waushakum. Station grown seed. 21 ears, all flint. Yellow, slate and red-splashed kernels.

Improved King Philip. 31 ears, all flint. Yellow, red-blazed, copper-yellow, black, slate, blotched and speckled kernels.

New England Twelve-rowed. 1 ear, all flint. Yellow and white kernels.

White flint. 28 ears, all flint. White, yellow, black and pink splashed kernels.

Red Nose White. 35 ears, all flint. White, yellow, pink, purple and blotched kernels.

Early Dutton. 29 ears, all flint. Slate, white, yellow and red splashed kernels.

Eight-rowed Purple. 23 ears, all flint. Purple, yellow, copper yellow and red-striped kernels.

Rural Thoroughbred. 15 ears, all flint. White, yellow and blue kernels.

Our Squaw flint is an eight-rowed corn. There seems to be a corelation between this and climate. In New England the great predominance of eight-rowed varieties is significant, yet there is an eight-rowed and a twelve-rowed Canada, but I have no record of the comparative frequency of the two varieties. The samples of soft corn sent me from the Red River region of Manitoba were eight-rowed, so also the dent varieties from Dakota. In my description of 44 varieties of flint corn in 1884, 28 eight-rowed varieties are suited for New England growing, and 8 twelve-rowed, two varieties, twelve-rowed, being foreign and hence not ascribed to American location. Those varieties which are more distinctly Southern or Western comprise one twelve-rowed, and five over twelve-rowed. Yet, since writing the above, I have received a small twelve-rowed variety of a slate or bluish black pop, which is said to ripen in eighty days in Massachusetts.

XIII.

In 1878 I received from the Peabody Museum collection a sample of corn taken from a Peruvian Huaca, and figured the same in the New York Agricultural Experiment Station Report of 1884. I also saw another like ear from the Cambridge Botanical Museum. In August, 1894, I received from Professor F. W. Putnam three samples from the Peabody Museum representing three varieties from ancient burials. Wittmack, whose specimens came mostly from Ancon, Peru, is quoted by DeCandolle as testifying that the number of varieties were quite considerable. The only varieties that I have noted described are two. Rivero and Tschudi say the ears buried with the corpse were of two very rare kinds. In one the ear short, dry and a little curved at the point; the other a large thin ear, with large grains almost triangular at the point, very much twined, with the grains covering it like the tiles of a roof. He then mentions a "petrified" ear in the possession of the botanist Robert Brown, which was one of these varieties, and which he calls *Zea rostrata*, Bonafous. DeCandolle refers apparently to this "petrified" ear, but he calls it "un imitation sculpter." In the Department of Agriculture Report of 1870 there is figured an ear in the possession of the Smithsonian Institution which was taken from an earthern vessel eleven feet under ground, in a grave with a mummy. From the figure little can be made out except the irregular arrangement of the kernels, but the description says 4½ inches long, 13 rows, the grains rather sharp-pointed, small, slightly indented at the apex, lapping over each other. The appearance is that of a soft corn.

This datum, all I have, is scarcely sufficient for the purpose of a study or for generalizations concerning "mummy corns," but there are some few points that can be referred to, and an accurate description of the four varieties may be of service as a record. The kernel color of these Peruvian samples is uniform chocolate brown, or the same with a more reddish tinge; of the Chilian samples a port-wine glossy red. The brown-chocolate we assume is a change induced by age. The split kernels show all starchy matter, of a dull white, and no corneous matter. The species is hence *Zea amylacea*, but the question recurs whether or not the internal structure has been changed by age; this we cannot answer. The kernels in all are deeper than broad, hence subspecies C.

No. 1. Mummy corn from Peru. Ear-stalk small. Ears about 4 in. long and 2 in. in diameter, cone-form or strongly tapering from a large and rounded butt to a rounded tip, about 23 kernels in a row, 18-rowed. No sulci between rows. Kernels ⅝ in. long, ¼ in. broad, the apex flat with slightly rounded corners, and the sides but little tapering, hence rather rectangular in outline, indented, slanting forwards a little in their position on the cob, hence giving an appearance of imbrication to the ear. Color externally a chocolate brown, internally a dull white. Structure all starchy matter, hence *Zea amylacea.*

No. 2. Mummy corn from Ancon, Peru. Expedition of F. A. Agassiz. Ear-stalk small. Ear 4 in. long, 1½ in. in diameter, tapering but slightly, the kernels rounding strongly over butt and tip, 19 kernels to a row, 12-rowed. No sulci between rows. The kernels $\frac{5}{16}$ in. long, ⅜ in. broad, distinctly creased indented, the apex flattish, the corners well rounded, the sides slightly tapering, set upright or at right-angles with the cob. Color externally chocolate brown, internally a dingy white. Structure all starchy, hence *Zea amylacea.*

No. 3. Mummy corn from Ancon, Peru. Expedition of Geo. A. Dorsey, 1891. Ear-stalk small. Ear 5¼ in. long, 1¾ in. in diameter, not filled at extreme tip, no sulci between rows, very close kernelled, nearly cylindrical, kernels rounded strongly over butt, tapering and finally pointed towards tip, 26 kernels in a row, 16-rowed; the kernel surface compressed, leaving a flat triangular apex with the point forward. The kernel nearly ½ in. long by ¼ in. broad, the apex flat with very slightly rounded corners, triangular in shape, and a point projecting at right angles on the chit side, the sides slightly tapering, set upright on the cob, the point overlapping slightly the kernel in front, thus giving the appearance of imbrication. Color externally chocolate brown with a reddish tinge, internally a dingy white. Structure, starchy throughout, hence *Zea amylacea.* This ear corresponds somewhat with the second variety of Rivero and Tschudi, but it is not *Zea rostrata.*

No. 4. Mummy corn from Iquique, Chili. Expedition of Geo. A. Dorsey, 1891. Ear-stalk small. Ear 3¼ in. long, 1½ in. diameter, tapering, rounded over butt and tip, no sulci between the rows, which are a little irregular, very close kernelled, about 17 kernels in a row, and 20-rowed. The kernels $\frac{7}{16}$ in. long, ¼ in. broad, strongly rounded at summit, tapering at the sides, set upright on the cob. Color externally a deep port wine glossy red, internally a dullish white, not as dingy as in Nos. 2 and 3. The structure all starchy matter, hence *Zea amylacea.* The general appearance of the specimen is that of a large kernelled very flinty pop corn. The kernels are so densely compressed that a horizontal section shows a polygonal outline, as is so readily observed in some varieties of Pearl pop.

XIV.

It is singular that nearly all the early corns mentioned in my Note II. were from Southern localities, as Nicaragua, Brazil and Paraguay. This was brought to my attention by noticing that the Cinquanto corn from Greece is one of the few varieties that ripens at Ottawa, Canada. The Danubian corn of Southeastern Europe, which to some extent enters into commerce, as near as I can find out, belongs to the Golden pop class, which is an early type, and Humboldt, it will be remembered, refers to a two-month variety in Hungary, the same as found in Nicaragua and on the banks of the Amazon river. The earliest variety I have ever grown is the Dwarf Golden pop which ripened in about 70 days from planting. The next earliest variety was the 40 days, a flint in some respects reminding of Canada flint, and which was ripe in 75 days, The only high Northern corn whose period of growth I find given is the Mitchell's Extra Early flint, gained by selection from the Native or Squaw flint of the Northwest. At Ottawa it required 110 days to ripen; at Nappan, Nova Scotia, 111 days in 1892, 126 days in 1893; at Agassiz, British Columbia, 138 days. In these regions it seems that this corn is harvested before it becomes as hard as with us.

The height of the corn plant varies considerably with the same variety, as also the time required to mature. Thus the Iowa

Experiment Station reports in 1888 on the Leaming dent, seed from four sources, as below:

	Height of plant.	Height of ear from ground	No. of blades to a stalk.	Days maturing.
Leaming (from Gregory)	9½ ft.	3¾ ft.	12	110 "
" (from Livingston)	9½ ft.	3¾ ft.	13	115 "
" (from Maule)	10¼ ft.	4¾ ft.	14	125 "
" (from Johnson & Stokes)	10½ ft.	5¼ ft.	15	128 days.

Further particulars from the State station reports are:

Leaming,	Illinois, 1888,	11¼ ft., tall.	Season 135 days.
"	Connecticut,	8 ft. tall.	
"	Ottawa, Can., 1889,	8 to 9 ft. tall.	
"	" " 1890.	7 to 10 ft. tall.	

Further illustrations are:

	Iowa, feet.	Illinois, feet.	New York, feet.	Ottawa, feet.
Adams' Early dent,	—	4¼ to 6½	5½	6 to 8
Minnesota Sweet,	4½ to 5	—	4½ to 5½	6 to 7

The height of the same corn in different years and planted at intervals of one week is given for Burr's White dent in the Illinois reports.

1891,	Eight plantings,	7⅚ to 8½ ft.,	Average 8 ft.
1892,	"	7⅙ to 9 ft.,	Average 8 5/12 ft.
1893,	Seven plantings,	5 7/12 to 7⅔ ft.,	Average 6¾ ft.

Two well known varieties of sweet corn are Crosby's Early and Stowell's Evergreen, both largely grown and used for canning purposes.

	Crosby's Early, Height in feet.	Stowell's Evergreen, Height in feet.
Michigan,	4	5¾
Illinois,	5½ to 7	6 to 8
New York,	5½ to 6	5½ to 7½
Pennsylvania,	6	6
N. W. Territory, Can.,	4½	—
Manitoba,	7	5 to 5½
Ottawa, 1889,	6½ to 7	5½ to 7
" 1890,	4½ to 5	5 to 6½

Would it be safe, then, to generalize from these figures that a northern climate increased earliness and decreased size in the corn plant? Yet this is the popular belief. On the contrary our presentation shows no such conclusions.

The Canada Yellow is reported as 5 to 6 feet tall from Ottawa and Manitoba. Mitchell's Extra Early flint, at Ottawa, grows to a height of 5½ to 6½ feet. Canada flint, from the Province of Quebec, at New York station, 1884, grew 6½ feet tall; and the Canada Twelve-rowed, from P. Q., grew 6½ feet tall. These few observations, put in evidence, suggest also like interesting reflections.

I have as yet insufficient experience or study to venture upon a statement as to the influence of climate upon maize except in its most general relations; of one thing I am assured, and that is the permanence of variety types under varied conditions, in every case I have met where there was reasonable prevention of interpollenation with other varieties. Thus the Dwarf Golden pop, whose ovules are fertilized before other varieties come into bloom, is a permanent feature to some gardens. In Northern Maine, where the crop is only grown on hill-sides to escape the early frost of the lowlands, standing thus remote, the variety seems to have remained true from the earliest periods. At our local agricultural fairs the same variety is often exhibited year after year, and no apparent change within the memory of observers. A search in Northern Maine or New Hampshire brings to our knowledge a few fields of corn which is presumably the Blue corn of the aborigines. The corn found with the Arizona mummy at the National Museum seems identical with the varieties grown by the present Indians of that region. So far as I know, in any climate suited to corn culture, any variety that matures between the period of local planting and local frost will grow and keep its characters intact. Perhaps a greater knowledge might cause me to change this statement.

The idea that we must go north for our seed is thus seen to be untenable, except so far that we only find corn in the north that will mature within certain periods. Far more plausible is the idea that we must seek an earlier corn by finding an earlier variety, whether north or south. Thus the Cinquanto from Greece ripened at Ottawa, while the King Philip which originated from New Hampshire is reported as only nearly ripe, and the Dutton, a New England form, as only in early milk.

Per contra, to this estimate of climate relations, I would call attention to the statement in my Note X. regarding the Mexican Indian corn and the *Zea canina*.

It is an interesting fact, which would not have been predicted by botanists, that in and about Farmington, Maine, where the Stowell Evergreen sweet does not ripen its seed, there is a large canning industry, and that the State of Maine cans more sweet corn than any other one State, amounting to 614,894 cases in 1891.

XV.

The application of hot water to starch causes it to become plastic. This fact seems to underlie the explanation of the popping of corn. Pop corn contains starch granules arranged within a tough endosperm. When heat is applied the starch becomes plastic, and the water furnishes steam which soon explodes the kernel, and, turning it inside out and expanding the starch, forms a large fluffy snow-white mass. It is only the corneous matter of the pop corn that furnishes the expanded mass of popped corn. When, as is sometimes the case, a small spot of starchy endosperm occupies the lower portion of the kernel, this remains unchanged or simply toasted. Flint corn does not pop becuuse its corneous endosperm is too thin. Upon the application of heat it does not evert, but only spits. From pop corn, therefore, we gain popped corn; from flint corn simply toasted corn or parched corn. Sweet corn and soft corn simply toast, and all the dent corns I have tried simply toast or spit.

When we consider the delicate quality of popped corn and its handsome appearance, as also its large consumption, both in its popped state and as candied, it is a matter of surprise how infrequent is the mention of it in books or other publications. Harsh berger says that Dr. Franklin mentions an Indian preparation. "A vessel of sand was heated. The corn was then mixed with this sand and slowly heated until the grain burst. It was then taken out and ground to a fine powder, which kept fresh for a number of years, Heckewelder calls this preparation *psindamocan*." Romans, in his "Natural History of Florida," writes that the natives "parch and then pound it, taking this pounded material on long journeys." According to Lambert's "History of the New Haven Colony," the Connecticut Indians called parched corn pounded, *yeokheag;* parched corn made into hominy, *roucheage.* The only other Indian names I have found for parched corn are: Caddo, *kishwanto;* Cherokee, *kungwisitung;* Choctaw, *tanchi vluvsha;* Mohawk, *ounouquit-zerleh;* Muskhogee, *achiaposiki;* Seneca, *onaershewfquaw.* The Quichuas of Peru call toasted maize *cancha.* *Pinole* is an Aztec word applied to any kind of grain or seeds parched and ground before being made into dough. I am unable to determine whether the word parched was used as synonymous with toasted or whether it refers to popped, but I suspect the former.

SOUTH FRAMINGHAM, October 4, 1894.

Japanese Characeae—I.

By T. F. ALLEN.

These observations will be continued as collections come to hand, and for the present no attempt will be made to systematize the species.

1. CHARA FRAGILIS Desv. A slender form of this species, differing in no particular from forms collected in other countries. The cortex is tolerably regular; the primary series most prominent, the papillae undeveloped. The bracts are unilateral and equal the oogonium in length, the latter immature.

2 and 3. CH. CORONATA A. Br. Three collections of this species have been made, all in the vicinity of Tokio; one form seems to be longer, with long leaves (probably from deeper water). It does not differ from the ordinary forms, even the minute tuft at the apex of the leaves, composed of the terminal cell with two or three elongated nodal bracts, is similar; this form is microcarpa, microptila, unilateralis. The coronula of the oogonium is short with spreading tips, the subtending bracts only half the length of the oogonium, the oospore small, 540 long, 306 broad.

4. NITELLA JAPONICA Allen, Bull. Torr. Club, **20**: 120; **21**: *pl. 188.* Province of Tokio.